5-1980

Evaluation of Seedbed Preparation & Alachlor Combinations for Weed Control in Soybeans

Ralph Young
Western Kentucky University

Young,

Ralph David

1980

EVALUATION OF SEEDBED PREPARATION AND ALACHLOR COMBINATIONS FOR WEED CONTROL IN SOYBEANS

A Thesis

Presented to

the Faculty of the Department of Agriculture

Western Kentucky University

Bowling Green, Kentucky

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Ralph David Young

May 1980

AUTHORIZATION FOR USE OF THESIS

Permission is hereby

[X] granted to the Western Kentucky University Library to make, or allow to be made photocopies, microfilm or other copies of this thesis for appropriate research or scholarly purposes.

[ ] reserved to the author for the making of any copies of this thesis except for brief sections for research or scholarly purposes.

Signed R. David Young

Date 5-15-80

Please place an "X" in the appropriate box.

This form will be filed with the original of the thesis and will control future use of the thesis.

EVALUATION OF SEEDBED PREPARATION AND ALACHLOR COMBINATIONS FOR WEED CONTROL IN SOYBEANS

Recommended May 14, 1980
(Date)

James P. Worthington
Director of Thesis

Roy E. Johnson

W C Norman

Approved May 30, 1980
(Date)

Elmer Gray
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express his sincere appreciation to the following:

Dr. James P. Worthington for his exceptional guidance, inspiration, and valuable counsel during the course of this study and for his help in preparing this thesis.

Dr. Wilbert C. Normand and Dr. Ray E. Johnson for their guidance and assistance during this study and their critical reading of the manuscript.

Ms. S. Ann Rogers for her help in obtaining data for this study.

TABLE OF CONTENTS

LIST OF TABLES

EVALUATION OF SEEDBED PREPARATION AND ALACHLOR COMBINATIONS FOR WEED CONTROL IN SOYBEANS

Ralph David Young   May 1980   36 pages

Directed by: Dr. J. P. Worthington

Department of Agriculture   Western Kentucky University

Alachlor [2'-chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide] in combination with linuron [3-(3,4-dichlorophenyl)-1 methoxy-1-methylurea (N'-(3,4-dichlorophenyl)-N-methoxy-N-methylurea)] and metribuzin [4-amino-6-tert-buytl-3-(methylthio)-as-triazin-5(4H)-one 4-amino-6-(1,1-dimethyethyl)-3-(methylthio)-1,2,4-triazin-5(4 H)-one] was evaluated for its control of broadleaf and annual grasses in Mitchell soybeans (<u>Glycine</u> <u>max</u> L.) under four different tillage conditions.

The experiment was conducted in the summers of 1978 and 1979. The tillage treatments evaluated were conventional tillage, double disking, single disking, and no-tillage. Alachlor at 2.2, 2.8, and 3.4 kg/ha was used alone and in combination with metribuzin at 0.4, 0.6, and 0.8 kg/ha and linuron at 0.6, 0.8, and 1.2 kg/ha. All treatments were compared with a check which received no residual herbicide application. All plots received an application of glyphosate [N,N-bis(phosphonmethyl) glycine] at 2.2 kg/ha to control emerged vegetation.

The results of the experiment showed no interaction between tillage conditions and herbicide applications. There were no significant differences in broadleaf weed control or

yields in the tillage plots for either 1978 or 1979. Significant differences were found in yields as affected by herbicide treatments in 1978, but none were found in 1979. Differences did not follow any logical pattern and were not consistent between years.

INTRODUCTION

Weed control presents a serious problem in minimum tillage and no-tillage operations in the production of soybeans. With the problem of rising fuel and labor costs, much attention is being concentrated on a way to obtain good weed control and to obtain acceptable yields in no-tillage and minimum tillage crops.

Many crops have traditionally been planted in a conventionally tilled seedbed to get good seed contact with the soil and also to provide a means of mechanical weed control (15, 29). However, because of the severe problems of soil erosion and moisture loss in Kentucky soils, new acres of corn (*Zea mays*) and soybeans are being produced in no-tillage operations each year.

No-tillage is a very effective means of controlling soil erosion by reducing the amount of run-off that occurs during periods of heavy rainfall. Weed control is a problem in non-tilled crops, but with new methods of herbicide application which are being introduced each year many acres that were previously not acceptable for no-tillage due to perennial weed problems can be converted from conventional tillage to no-tillage. The recent introduction of the wick applicator and the recirculating sprayer have made weed control in no-tillage soybeans more efficient.

The purpose of this study was to evaluate the effectiveness of several residual herbicides used in different levels of tillage for weed control in soybeans. It proposed to show that when adequate weed control is maintained there will be no difference in yields of non-tilled or conventionally-tilled soybeans.

REVIEW OF LITERATURE

Many crops have traditionally been planted into a conventionally tilled seedbed to obtain good seed contact with the soil and also to provide a means of mechanical weed control (15, 29). However, because of the severe problem of soil erosion and moisture loss in Kentucky soils, crops are being grown in no-till farming systems (25).

Since the late 1950's, studies have been conducted on the effectiveness of no-tillage planting. Kentucky has traditionally been a leader in no-tillage research and farming. This method of planting utilizes the previous year's crop residue and the fact that the soil is not disturbed to significantly reduce soil erosion and the amount of the water run-off. These residues will lower soil temperatures and hold available water more efficiently than conventionally tilled soils (10). However, residues left on the surface have been shown to reduce herbicide activity. This reduction will hold true for minimum tillage as well as no-tillage because the residues absorb the herbicides (24). Some studies have shown no significant effect of residue amounts on herbicide activity, but it is usually thought that plant residues on the surface have an effect on herbicide activity. Thus increased rates of herbicides are required (10, 15).

Weed control is essential in crop production. McWhorter and Hartwig found that heavy infestations of johnsongrass (*Sorghum halepense*) reduced soybean yields from 23% to 43% and that heavy infestations of common cocklebur (*Xanthium pensylvanius* Walk.) reduced average yields from 63% to 75% (19, 21). Weed control has traditionally been found to be the major problem encountered in minimum-tillage and no-tillage operations (15, 19, 24, 25, 29). No-tillage weed control is limited to the use of chemicals. Herbicide weed control programs for no-tillage usually involve some type of post-emergence broad spectrum herbicide in combination with one or more pre-emergence residual materials for annual grass and broadleaf control (10, 15, 29).

Johnsongrass has been found to be one of the most difficult weeds to control in no-tillage soybeans. This difficulty is partially due to the fact that it does not translocate herbicides to dormant buds. The buds emerge later and cannot be controlled by the pre-emergence herbicides available for no-tillage areas (20). Johnsongrass competes strongly with soybeans, and it is usually thought that no-tillage areas should be planned to avoid heavy johnsongrass infestations (15, 19, 21, 27). No-tillage double-cropped soybeans have been shown to have high economic returns when compared to full season soybeans. Proper selection of herbicides for no-till soybeans is very important (7). Until recently, the major post-emergence herbicide used was paraquat [1, 1'-dimethyl-4, 4' bipyridium ion], which is a contact material and is not translocated. With the introduction of glyphosate in 1971, many farmers are beginning to use it in their no-till operations. Paraquat and glyphosate have equal control of emerged annual weeds, but glyphosate provides better control of perennial weeds (5, 11, 15, 17).

Chemical weed control in no-tillage and minimum tilled soybeans is limited to pre-emergence residual and post-emergence herbicides. The pre-plant incorporated herbicides, such as trifluralin [a, a, a-trifluoro-2, 6-dinitro-N, N-dipropyl-p-toluidine] and fluchloralin [N-(2-chloroethyl)-2, 6 dinitro-N-propyl-4 (trifluoromethyl) analine (N-(2-chloroethyl)-a, a, a-trifluoro-2, 6-dinitro-N-propyl-p-toluidine], are of no use in no-till soybeans (13, 15). To obtain acceptable control of weeds, pre-emergence materials, such as alachlor, metribuzin, and linuron, are used to control annual and broadleaf weeds (3, 13, 15, 22, 23, 25). For post-emergence treatment it is usually thought that glyphosate, paraquat, or bentazon [3, isopropyl-1-2, 1, 3-benothiodiazin-4 (3 H)-one 2, 2 dioxide] will usually give acceptable control of emerged annual and perennial weeds (5, 11, 13, 15, 17). Bentazon is a selective post-emergence treatment, and glyphosate and paraquat are non-selective (13). Residual pre-emergence herbicides are used to control weed seedlings for a short time during the growing season. Since the main problem in no-till soybeans is weed control, many different combinations of pre-emergence residual materials should be considered to obtain acceptable weed control (15).

Alachlor is a residual material of the acid amide herbicide group and is generally used for control of most annual grasses, yellow nutsedge (Cyperus esculentus), and certain broadleaf weeds (11, 12, 13). It can be applied preemergence, early post-emergence, or pre-plant incorporated. The recommended rates vary from 2.2 to 3.4 kg/ha (13).

Kapusta reported that in conventionally tilled fields, alachlor has given better than 90% control of annual grasses and 80% control in no-tilled areas with no significant yield differences (15). He also reported that overall effectiveness was dependent on the amount of rainfall after alachlor was applied to the no-tilled areas as a pre-emergence application. He stated that low rainfall during the first month would inhibit incorporation and thus reduce effectiveness of the alachlor and most other pre-emergence residual herbicides (12, 15).

Alachlor has been shown to be very effective on yellow nutsedge when used at the rate of 3.4 and 4.5 kg/ha with 4.5 kg/ha giving the best control (3). When applied at the proper time, alachlor will be absorbed by yellow nutsedge seedlings through the shoot or roots and then be translocated to the growing points which will result in reduced growth and eventual death to the plant (3, 12). After the alachlor has entered yellow nutsedge (and other plants which it controls), protein synthesis of the susceptible plants is interrupted (13).

Alachlor has been effectively used in soybeans with very little crop injury (9, 31). If crop injury to soybeans does occur, the leaflets will have a very rough, wrinkled surface. Restricted growth of the leaf margins causes some cupping and wedge-shaped leaflets. Also, plants will be slightly stunted (4).

The activity of alachlor has been shown to be directly related to soil moisture and temperature (12, 22). Cold weather or other environmental factors which reduce activity of plants will reduce effectiveness of alachlor. These factors were believed to be due to the fact that plants that are not actively growing will not translocate toxic materials as rapidly as plants under ideal growing conditions (12).

Alachlor gives limited control of broadleaf weeds, and some type of residual material that is effective against broadleaf plants should be used in combination with alachlor. Metribuzin and linuron are both excellent herbicides for broadleaf control (1, 13). Metribuzin is effective against some annual grasses and difficult to control weeds, such as cocklebur and jimson weed (Datura stromanium). Metribuzin is usually applied as a pre-emergence or early post-emergence material (13, 18, 26, 30).

Linuron selectively controls germinating and newly established broadleaf weeds and grasses. It is used as a pre-emergence or post-emergence treatment. When a suitable surfactant is used, linuron can control weeds up to 5 inches in height when applied as a post-emergence treatment. It is usually applied at rates varying from 0.5 to 1.2 kg/ha (1, 13).

Kapusta reported that there were no significant differences in effectiveness between metribuzin and linuron for the control of most common broadleaf weeds when used in combination with alachlor. He reported that metribuzin did afford better control of ivyleaf morningglory (*Impomoea hederacea*) than did linuron. There were also no significant differences found among the alachlor plus metribuzin or alachlor plus linuron combinations for soybean yields in conventional, minimum, or no-tilled soybeans (15).

Injury symptoms for linuron and metribuzin are identical. When either is applied under adverse weather conditions or when applied at greater than label rates, leaf necrosis, leaf drop, and death of plant may occur (4, 31). Linuron has been one of the most effective pre-emergence herbicides in no-tillage soybeans, but many times growers will experience crop damage from this hebicide. Soybeans grown under no-tillage conditions seem to be less susceptible to linuron damage since the soil moisture and temperature are more stable than conventionally tilled soil (31).

It has also been reported that the use of linuron on organic soils will reduce microbial population and will cause a problem with carry-over of the herbicides. Crops sensitive to linuron in these soils will be affected in some cases and yields will be greatly reduced. The carry-over seems to last for a one-year period (16).

Silva and Warren reported that when applied as a post-emergence treatment, metribuzin gave very good control of jimsom weed, common lamsquarters (Chenopodium album), red-root pigweed (Amaranthis retroflexus), and several other broadleaf species. They also found that when metribuzin was applied to foliage after an insecticide or fungicide treatment, very little decrease was noted in activity of the herbicide (28).

Linuron and metribuzin both give some limited post-emergence control of selected weeds; however, to get adequate control of emerged weeds prior to planting, a more broad spectrum herbicide should be used for the post-emergence treatment in weed control. Paraquat has traditionally been the standard treatment for controlling emerged weeds in preparing for no-till planting. However, with an increasing concern about how to control perennial weeds, success has been shown when using glyphosate, which is a broad-spectrum, non-selective material (15).

Glyphosate was first introduced in 1971. It is applied to the foliage of emerged plants and is then translocated throughout all parts of the plant, and it is more effective than paraquat for controlling perennial weeds, such as johnsongrass. However, it has also been shown to be more adherent to plants (5, 25). Nevertheless, if glyphosate drifts, it will result in injury to the adjacent crops, thus making it necessary to use a low pressure flooding nozzle tip when applying the herbicide. This material has resulted in limited control of volunteer wheat (Tritium aestium L.) and sorghum (Sorghum bicolor) in minimum tillage. It also has been shown to give excellent control of yellow nutsedge and johnsongrass in preparing sod for no-till planting of crops (5, 17).

McWhorter and Azlin reported that glyphosate was extremely toxic to both johnsongrass and soybeans when the plants were at optimum growing conditions. It was noted that as soil moisture was near field capacity and the temperature was about 35 degrees C, glyphosate gave better than 90% control of johnsongrass. However, when johnsongrass was growing under low soil moisture and low relative humidity, control was significantly reduced from the treatments which were applied under optimum growing conditions. The study also showed that when a surfactant was added to glyphosate, control of johnsongrass was increased six days after the treatment, but control ratings were not different at fourteen days after application. They concluded that temperatures and soil-moisture conditions suitable for optimum growth of johnsongrass also were most favorable for its control with glyphosate (17).

It has also been reported that glyphosate toxicity can be reduced when combined with certain wettable powders (27). It was reported that bromacil [5-bromo-3-sec-butyl-b-methyluracil] and diuron [3-(3, 4-dichlorophenyl)-1, 1-dimethylurea] reduced glyphosate toxicity to common milkweed (<u>Asclepias syrica</u>). Several more antagonistic effects were noted among many popular herbicides, such as atrazine 2-chloro-4(ethylamino)-6-(isopropylamino)-s-(triazine) and simazine [2-chloro-4-, 6-bis(ethylamino)-s-(triazine)]. It was also noted that calcium, iron, zinc, and aluminum will reduce glyphosate's toxicity, with calcium having the greatest negative effect. However, it was noted that calcium in spray water did not present a problem as long as the diluent volume was 190 L/ha or less (27).

According to the Herbicide Handbook of the Weed Science Society of America, the mode of action of glyphosate is not fully understood (13). After addition of the material, it usually takes about four days before any visible signs of plant damage occur (13, 27). It has also been reported that glyphosate is apparently broken down immediately upon contact with the soil and that no residual effects persist. Glyphosate has shown no effect on non-growing plant material, such as seeds. Egley and Williams reported that glyphosate had no effect on several different weed seeds and was actually observed to increase redroot pigweed seed germination (27).

MATERIALS AND METHODS

Research was conducted on the Western Kentucky University Farm in Bowing Green, Kentucky, during the summers of 1978 and 1979 to evaluate the effects of residual herbicides and varying degrees of tillage on weed control in soybeans. Chosen each year was a site which had been in corn the previous year. The soil type was a Pembroke silt loam. The experimental design was a split-plot with four replications. The tillage treatments were main plots and were divided into ten sub-plot herbicide treatments.

The experimental area was divided into four main plot treatments consisting of (1) a conventionally tilled area which was moldboard plowed and disked, (2) an area which was disked once, (3) an area which was disked twice, and (4) one section which was not tilled. These tillage treatments were used for 1978 and 1979. The main plot dimensions were 36m by 30m, and the sub-plots were 3m by 30m with four rows treated with herbicide.

Mitchell soybeans were planted on June 13, 1978, and on June 14, 1979, with a two row no-till planter. Herbicide applications were made on June 14, 1978, and on June 15, 1979, at the following rates: All areas received an application of glyphosate at a rate of 2.2 kg/ha. Individual treatments of alachor at 2.2, 2.8, and 3.4 kg/ha were used alone and in combination with metribuzin at 0.4, 0.6, and 0.8 kg/ha or with linuron at 0.6, 0.8, and 1.2 kg/ha. The herbicides were applied with a four row plot sprayer using a flooding nozzle tip to reduce drift. The pressure was maintained at 1.3 kg/cm^3 with a roller pump, and the herbicides were applied in a total volume of 190 L/ha.

Weed control ratings for treatments were taken visually and expressed as percentages. In 1978, there was only one rating taken at approximately four weeks after planting; in 1979, three ratings were taken at approximately 4, 8, and 12 weeks after planting.

Yield data were obtained by harvesting the four rows in each treatment with a conventional combine with a 3.7m cutting head. Soybeans were weighed and adjusted to 13% moisture. Foreign material was removed prior to weighing. The soybeans were harvested on October 3, 1978, and on October 29, 1979.

RESULTS AND DISCUSSION

Effects of tillage on annual broadleaf and grass weeds for 1978 and 1979

There were no significant differences among tillage treatments for broadleaf weed control with all treatments giving better than 90% control (Table 1).

There were significant differences among tillage treatments for control of annual grass (Table 1). Those treatments which received some degree of mechanical tillage did give significantly higher control of annual grasses than did the no-tillage weed control treatment. In the single-disked area, control was significantly lower than the conventional tillage. Significant differences were noted, but all treatments gave acceptable control of annual grass.

No significant differences were found among any of the tillage treatments for broadleaf control in 1979 at 4, 8, or 12 weeks after planting (Table 2). All tillage treatments had excellent control of broadleaf weeds with all having greater than 88% control four weeks after planting.

There were no significant differences found among any of the tillage treatments for annual grass control in 1979 at 4, 8, or 12 weeks after planting, except that the double-disked area was significantly lower in grass control than all other treatments (Table 3). The annual grasses most difficult

Table 1. Effect of tillage on annual broadleaf and grass weeds in 1978.[a]

Tillage	1978	
	Broadleaf control	Annual grass control
	%	
A. Conventional	94.17a	94.90a
B. Single disking	95.30a	90.60b
C. Double disking	94.05a	91.77ab
D. No-till	93.05a	85.50c

[a]Means within each column followed by the same letter are not significantly different at the 1% level by Duncan's multiple range test.

Table 2. Effect of tillage on broadleaf weed control in 1979.[a]

Tillage	1979		
	4 week control	8 week control	12 week control
	%		
A. Conventional	92.72a	77.75a	96.12a
B. Single disking	91.70a	78.25a	96.65a
C. Double disking	88.45a	72.82a	96.60a
D. No-till	96.77a	79.87a	95.82a

[a]Means within each column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Table 3. Effect of tillage on annual grass control in 1979.[a]

Tillage	1979		
	4 week control	8 week control	12 week control
	%		
A. Conventional	94.15a	82.97a	89.02a
B. Single disking	87.50a	77.37a	83.47a
C. Double disking	72.52b	57.55b	50.87b
D. No-till	96.52a	76.65a	87.85a

[a]Means within each column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

CORRECTION

PRECEDING IMAGE HAS BEEN REFILMED
TO ASSURE LEGIBILITY OR TO CORRECT A POSSIBLE ERROR

to control were crabgrass (Digitaria) and fall panicum (Panicum dichotomiflorum).

Effects of tillage on yields of soybeans in 1978 and 1979

There were no significant differences among yields as affected by tillage in either 1978 or 1979 (Table 4). This consistency would seem to indicate that when adequate weed control is maintained, there will be no differences found in yields from no-tillage as compared to conventional tillage. These results seem to be in agreement with Kapusta. He reported that when weed control was maintained, there would be no significant differences in yields of no-tilled or conventionally tilled soybeans (15).

Effects of herbicide and rate on control of annual broadleaf and grass weeds in soybeans for 1978 and 1979

All treatments resulted in better than 90% control of annual broadleaf weeds in 1978 (Table 5). However, most plots which received alachlor in combination with linuron and metribuzin gave significantly higher control than the check. The check area which received 2.2 kg/ha of glyphosate as a non-selective, post-emergence application gave above 90% control of annual broadleaf and grass weeds. Typically, it is not expected to have any residual activity since it is readily de-activated upon contact with the soil.

There were no significant differences found among alachlor treatments in combination with linuron and metribuzin for control of annual grass in 1978. Annual grass control from treatments which received alachlor alone were significantly poorer than most other treatments (Table 5).

Table 4. Effect of tillage on soybean yields in 1978 and 1979.[a]

Tillage	Yields	
	1978	1979
	(kg/ha)	(kg/ha)
A. Conventional	1557.40a	2083.31a
B. Single disking	1387.74a	1509.91a
C. Double disking	1522.14a	2181.97a
D. No-till	1289.44a	2192.44a

[a]Means within each column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

Table 5. Effect of herbicides on annual broadleaf and grass weeds in 1978.[a]

Herbicides[b], Rate (kg/ha)	1978	
	Broadleaf control	Annual grass control
	%	
A. alachlor 2.2	92.62ab	89.37bcd
B. alachlor 2.8	93.31ab	85.56d
C. alachlor 3.4	93.25ab	88.62cd
D. alachlor 2.2+ metribuzin .4	95.25a	90.56abc
E. alachlor 2.8+ metribuzin	93.81ab	91.31abc
F. alachlor 3.4+ metribuzin .8	96.06a	93.06a
G. alachlor 2.2+ linuron .6	95.18a	91.43a
H. alachlor 2.8+ linuron .8	94/56ab	92.31a
I. alachlor 3.4+ linuron 1.2	95.87a	91.81ab
J. check	91.50b	90.87abc

[a]Means within each column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

[b]All plots received 2.2 kg/ha of glyphosate.

There were no significant differences found among any of the herbicide treatments for control of annual grass in 1979 at 4, 8, or 12 weeks after planting (Table 6). Growing conditions were ideal in 1979 and could partially account for the uniformity in herbicide activity. Also there was considerably less residue on the soil in 1979 than in 1978 (Table 7). It is conceivable that residues on the soil in 1978 caused reduced activity of herbicides. Both of these could be possible explanations; however, further testing would be required to confirm these theories.

There were no significant differences found among any herbicide treatments for broadleaf weed control in 1979 at 4, 8, or 12 weeks after planting (Table 8). Broadleaf pressure was low as evidenced by control in the check area which received no residual herbicide application. Usually under normal growing conditions, alachlor alone would not be expected to give adequate control of broadleaf weeds. It is primarily used for control of annual grass and yellow nutsedge and has limited activity on broadleaf species.

Effects of rate and type of herbicide on yields of soybeans in 1978 and 1979

In 1978, there were highly significant differences found among several of the herbicide combinations (Table 9). Those plots which received 2.8 kg/ha of alchlor plus 0.6 kg/ha of metribuzin, 2.2 kg/ha of alachlor plus 0.6 kg/ha of linuron and 3.4 kg/ha of alachlor plus 1.2 kg/ha of linuron were significantly higher yielding than those plots which re-

Table 6. Effect of herbicides on annual grass control in 1979.[a]

Herbicides[b], Rate (kg/ha)	1979		
	4 week control	8 week control	12 week control
	%		
A. alachlor 2.2	88.63a	65.56a	80.50a
B. alachlor 2.8	88.63a	70.93a	81.00a
C. alachlor 3.4	87.93a	76.93a	75.56a
D. alachlor 2.2+ metribuzin .4	85.12a	72.75a	81.37a
E. alachlor 2.8+ metribuzin .6	86.87a	71.56a	74.87a
F. alachlor 3.4+ metribuzin .8	89.18a	80.87a	76.75a
G. alachlor 2.2+ linuron .6	90.37a	76.81a	75.68a
H. alachlor 2.8+ linuron .8	86.81a	75.62a	70.63a
I. alachlor 3.4+ linuron 1.2	90.18a	77.06a	81.12a
J. check	83.00a	68.25a	80.56a

[a]Means within each column followed by the same letter are not significantly different at the 5%level by Duncan's multiple range test.

[b]All plots received 2.2 kg/ha of glyphosate.

Table 7. Crop residue for tillage treatments for 1978 and 1979.[a]

Tillage	1978	1979
A. Conventional	0	0
B. Single disking	2.7	0.7
C. Double disking	1.2	0.5
D. No-till	6.5	0.9

[a]All numbers are reported in metric tons/ha.

Table 8. Effect of herbicides on broadleaf weed control in 1979.[a]

Herbicides[b], Rate (kg/ha)	1979		
	4 week control	8 week control	12 week control
	%		
A. alachlor 2.2	93.56a	73.12a	97.12a
B. alachlor 2.8	93.75a	77.93a	94.93a
C. alachlor 3.4	94.62a	78.75a	96.37a
D. alachlor 2.2+ metribuzin .4	93.06a	75.43a	97.37a
E. alachlor 2.8+ metribuzin .6	93.87a	76.25a	94.18a
F. alachlor 3.4+ metribuzin .8	92.06a	81.25a	97.37a
G. alachlor 2.2+ linuron .6	93.25a	79.37a	96.93a
H. alachlor 2.8+ linuron .8	93.31a	79.93a	95.25a
I. alachlor 3.4+ linuron 1.2	90.37a	80.93a	96.93a
J. check	86.25a	68.75a	96.62a

[a]Means within each column followed by the same letter are not significantly different at the 5% level by Duncan's multiple range test.

[b]All plots received 2.2 kg/ha of glyphosate.

Table 9. Effects of rate and type of herbicide on soybean yields in 1978 and 1979.[a]

Herbicides[b], Rate (kg/ha)	Yields	
	1978	1979
	(kg/ha)	(kg/ha)
A. alachlor 2.2	1343.09c	1928.48a
B. alachlor 2.8	1320.93c	2084.18a
C. alachlor 3.4	1332.56c	2008.20a
D. alachlor 2.2+ metribuzin .4	1360.54c	2068.61a
E. alachlor 2.8+ metribuzin .6	1583.98ab	2024.74a
F. alachlor 3.4+ metribuzin .8	1399.56bc	1904.64a
G. alachlor 2.2+ linuron .6	1542.15ab	1973.43a
H. alachlor 2.8+ linuron .8	1522.88abc	1947.09a
I. alachlor 3.4+ linuron 1.2	1630.19a	1941.18a
J. check	1355.89c	2037.78a

[a]Means within each column followed by the same letter are not significantly different at the 1% level by Duncan's multiple range test.

[b]All plots received 2.2 kg/ha of glyphosate.

ceived alachlor alone, 2.2 kg/ha of alachlor plus 0.4 kg/ha of metribuzin, and the check; but the yields were not significantly different from all treatments.

In 1979, there were no significant differences found among any of the herbicide treatments (Table 9). The uniformity of yields was consistent with broadleaf and annual grass control in 1979.

General Observations

The results of this study indicated that when the proper herbicides are used and when weed control is maintained at adequate levels, there will be no differences in yields when no-tillage and conventional tillage are compared. There were some indications that the amount of residue on the soil at the time of herbicide application will have an effect on herbicide activity, a possible explanation for the more uniform weed control experienced in 1979 as compared to 1978. This theory, however, would require further tests of residue effects on herbicide activity for confirmation. This study shows that there are no significant differences in yields when no-tillage is compared to conventional tillage; thus it would seem to indicate that with rising cost of fuel and labor many farmers should consider no-tillage as a part of their operation.

It is commonly accepted that no-tillage is excellent on sloping land because of the reduced soil erosion, but it also is very beneficial on flat land due to better utilization of soil moisture.

APPENDIX

Table 1. Analysis of variance of the 1978 annual grass weed control rating.

Source of variation	df	SS	MS	F
Total	159	4437.00	27.90	
Blocks	3	135.33	45.10	.91
Tillage	3	1830.83	610.20	12.37**
Error (a)	9	444.16	49.35	
Herbicide	9	417.68	46.40	4.02**
Tillage x Herbicide	27	362.24	13.41	1.16
Error (b)	108	1246.79	11.54	

**Significant at the 1% level.

Table 2. Analysis of variance of the 1978 broadleaf weed control rating.

Source of variation	df	SS	MS	F
Total	159	4075.00	25.62	
Block	3	809.32	269.70	3.86*
Tillage	3	99.00	33.00	.47
Error (a)	9	628.75	69.86	
Herbicide	9	318.00	35.33	1.99*
Tillage x Herbicide	27	306.40	11.34	.64
Error (b)	108	1913.53	17.71	

*Significant at the 5% level.

Table 3. Analysis of variance of the 1978 soybean yields.

Source of variation	df	SS	MS	F
Total	159	18,989,106.00	119,428.30	
Block	3	3,250,549.20	1,083,516.40	2.50
Tillage	3	1,836,820.73	612,273.56	1.41
Error (a)	9	3,907,831.44	434,203.48	
Herbicide	9	1,989,236.75	221,026.30	3.45**
Tillage x Herbicide	27	1,093,308.29	40,492.89	.63
Error (b)	108	6,911,359.66	63,994.00	

**Significant at the 1% level.

Table 4. Analysis of variance of the 1979 broadleaf weed control four weeks after planting.

Source of variation	df	SS	MS	F
Total	159	15,126.00	95.13	
Block	3	1,453.25	484.40	1.89
Tillage	3	1,414.75	471.50	1.84
Error (a)	9	2,299.80	255.53	
Herbicide	9	870.50	96.72	1.34
Tillage x Herbicide	27	1,319.75	48.87	.67
Error (b)	108	7,767.95	71.92	

Table 5. Analysis of variance of the 1979 broadleaf weed control eight weeks after planting.

Source of variation	df	SS	MS	F
Total	159	23,163.10	145.67	
Block	3	1,580.75	526.95	1.12
Tillage	3	1,107.85	369.31	.78
Error (a)	9	4,238.00	470.87	
Herbicide	9	2,200.75	244.53	2.40
Tillage x Herbicide	27	3,009.40	111.45	1.09
Error (b)	108	11,026.35	102.09	

Table 6. Analysis of variance of the 1979 broadleaf weed control twelve weeks after planting.

Source of variation	df	SS	MS	F
Total	159	4,516.00	28.40	
Block	3	732.75	244.25	3.66
Tillage	3	15.25	5.00	.07
Error (a)	9	600.40	66.70	
Herbicide	9	165.00	18.33	.94
Tillage x Herbicide	27	910.25	33.71	1.74
Error (b)	108	2,092.30	19.37	

Table 7. Analysis of variance of the 1979 annual grass weed control four weeks after planting.

Source of variation	df	SS	MS	F
Total	159	34,574.00	217.40	
Block	3	2,240.35	746.78	.96
Tillage	3	13,996.90	4,665.60	6.01*
Error (a)	9	6,982.75	775.86	
Herbicide	9	765.00	85.00	1.07
Tillage x Herbicide	27	2064.00	76.44	.96
Error (b)	108	8,525.00	78.90	

*Significant at the 5% level.

Table 8. Analysis of variance of the 1979 annual grass weed control eight weeks after planting.

Source of variation	df	SS	MS	F
Total	159	57,949.00	364.46	
Block	3	3,183.00	1,061.00	.72
Tillage	3	14,761.65	4,920.55	3.22
Error (a)	9	13,331.15	1,481.23	
Herbicide	9	3,130.30	347.81	1.93
Tillage x Herbicide	27	4,057.50	150.27	.83
Error (b)	108	19,485.45	180.42	

Table 9. Analysis of variance of the 1979 annual grass weed control twelve weeks after planting.

Source of variation	df	SS	MS	F
Total	159	90,587.00	6,230.10	
Block	3	2,155.27	718.42	.35
Tillage	3	39,366.57	13,122.19	6.42*
Error (a)	9	18,377.23	2,041.91	
Herbicide	9	1,913.68	212.63	.90
Tillage x Herbicide	27	3,128.96	115.88	.49
Error (b)	108	25,645.29	237.45	

*Significant at the 5% level.

Table 10. Analysis of variance of the 1979 soybean yields.

Source of variation	df	SS	MS	F
Total	159	49,842,250.00	313,473.20	
Block	3	2,527,209.19	842,403.06	.46
Tillage	3	12,691,878.00	4,230,626.00	2.32
Error (a)	9	16,492,783.50	1,832,531.50	
Herbicide	9	550,592.60	61,176.95	.48
Tillage x Herbicide	27	3,448,566.00	127,724.66	.98
Error (b)	108	14,131,220.71	130,844.63	

LITERATURE CITED

1. Anderson, W. P. 1977. Weed science principles. New York. 598 pp.

2. Armstrong, T. F.; W. F. Meggit; and Donald Penner. 1973. Absorption, translocation, and metabolism of alachlor by yellow nutsedge. Weed Sci. 21: 357-359.

3. Armstrong, T. F.; W. F. Meggit; and Donald Penner. 1973. Yellow nutsedge control with alachlor. Weed Sci. 21: 354-356.

4. BASF. Wyandotte Corp. Herbicide injury symptoms and diagnosis. 31 pp.

5. Baur, J. R. and R. W. Bovey. 1975. Herbicidal effects of febuthiuron and glyphosate. Agron. J. 67: 547-553.

6. Bennett, O. L.; E. E. Mathias; and C. B. Sperow. 1976. Double cropping hay and no-tillage corn production as affected by sod species with rates of atrazine and nitrogen. Agron. J. 68: 250-254.

7. Camper, H. M., Jr.; C. F. Genter; and K. E. Loope. 1972. Double cropping following winter barley harvest in eastern Virginia. Agron. J. 64: 1-3.

8. Carreker, J. R.; J. E. Box, Jr.; R. N. Dawson; E. R. Beaty; and H. D. Morris. 1972. No-till corn in fescue grass. Agron. J. 64: 500-503.

9. Chandler, J. M.; E. Basler; and P. W. Santelmann. 1974. Uptake and translocation of alachlor in soybean and wheat. Weed Sci. 22: 253-258.

10. Erbach, D. C. and W. C. Lovely. 1975. Effect of plant residue on herbicide performance in no-tillage corn. Weed Sci. 23: 512-515.

11. Egley, G. H. and R. D. Williams. 1978. Glyphosate and paraquat effect on weed seed germination and seedling emergence. Weed Sci. 26: 249-251.

12. Hargrove, R. S. and M. G. Merkle. 1971. The loss of alachlor from the soil. Weed Sci. 19: 652-654.

13. Herbicide Handbook of the Weed Science Society of America. 1979. 4th ed. Weed Sci. Soc. of Am. Champaign, Ill. 479 pp.

14. Hill, G. D., Jr.; I. J. Beloseo; and H. L. Ploeg. 1964. Influence of surfactants on the activity of diuron, linuron, and bromacil as foliar sprays on weeds. Weeds. 13: 103-106.

15. Kapusta, G. 1979. Seedbed tillage and herbicide influence on soybean weed control and yield. Weed Sci. 27: 520-526.

16. Mathur, S. P.; A. Belanger; S. U. Khan; H. A. Hamilton; R. Greenhalgh; and K. A. MacMillan. 1976. Influence of field-applied linuron and paraquat on the microflora of an organic soil. Weed Res. 16: 183-189.

17. McWhorter, C. G. and W. R. Azlin. 1978. Effects of environment on the toxicity of glyphosate to johnsongrass and soybeans. Weed Sci. 26: 605-608.

18. McWhorter, C. G. and J. M. Anderson. 1976. Effectiveness of metribuzin applied pre-emergence for economical control of common cocklebur in soybeans. Weed Sci. 24: 385-390.

19. McWhorter, C. G. 1972. Factors affecting johnsongrass rhizome production and germination. Weed Sci. 20: 41-45.

20. McWhorter, C. G. and E. E. Hartwig. 1968. Competitiveness of soybean varieties with johnsongrass and cocklebur. Miss St. Univ. Exp. Sta. bull. ID-1037. 2 pp.

21. McWhorter, C. G. and E. E. Hartwig. 1972. Competition of johnsongrass and cocklebur with six soybean varieties. Weed Sci. 20: 56-59.

22. Mulder, C. E. G. and J. D. Nalewaja. 1978. Temperature effect of phytotoxicity of soil-applied herbicides. Weed Sci. 26: 566-570.

23. Penner, D. and R. W. Early. 1973. Effect of alachlor, buytlate, and chlorbromuron on carbofuron distribution and metabolism in barley and corn. Weed Sci. 21: 360-362.

24. Robinson, L. R. and H. D. Wittmuss. 1973. Evaluation of herbicides for use in zero and minimized tilled corn and sorghum. Agron. J. 65: 283-286.

25. Rogers, C. B. 1976. Evaluation of glyphosate in no-till double crop soybeans using various volumes and pressures. Masters Thesis. W.K.U. Bowling Green, Ky. 38 pp.

26. Savage, K. E. 1976. Absorption and mobility of metribuzin in the soil. Weed Sci. 24: 525-528.

27. Sandberg, C. L.; W. F. Meggit; and D. Penner. 1978. Effect of diluent volume and calcium on glyphosate phytotoxicity. Weed Sci. 26: 476-479.

28. Silva, J. F. da; and G. F. Warren. 1976. Effect of stage of growth on metribuzin tolerance. Weed Sci. 24: 612-615.

29. Triplett, G. B., Jr. and G. D. Lytle. 1972. Control and ecology of weeds in continuous corn grown without tillage. Weed Sci. 20: 453-457.

30. Webster, G. R. B. and G. J. Reimer. 1976. Field degradation of the herbicide metribuzin and its degradation products in a Manitoba loam soil. Weed Res. 16: 191-196.

31. Worsham, A. D. 1974. Influence of no-tillage planters on tolerance of soybeans to linuron. Weed Sci. 22: 340-344.

VITA

Ralph David Young was born in Clearwater, Florida, on June 5, 1956. He attended White Plains Elementary School and Allen County High School in Scottsville, Kentucky, where he graduated in 1974. He entered Western Kentucky University in 1975 and received the Bachelor of Science Degree in May, 1978. He then became a candidate for the Master of Science Degree in Agriculture at Western Kentucky University.